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Cathode ray tube device with an in-line electron gun

Abstract:

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(54) Cathode ray tube device with an in-line electron gun

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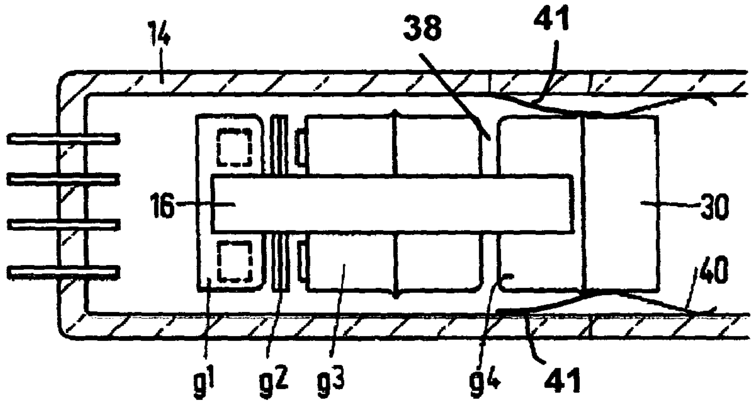

FIG.3

EP 1 536 451 A1

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a colour cathode ray tube having an envelope comprising a neck, and a triple beam in-line electron gun in the neck and means for reducing convergence drift.

[0002] Such a colour cathode ray tube is known from United States Patent US 4,868,454.

[0003] In an in-line electron gun, particularly a gun in which corresponding electrodes are implemented as unitary electrodes, the various juxtaposed electrodes are held together by glass beads disposed on opposite sides of a plane, the so-called in-line plane, containing the beam paths of the three electron beams. Viewed in cross section the glass beads can be regarded as being arranged north and south and the plane may be regarded as extending east-west. In the case of the electron gun including a bipotential focusing lens then this lens is constituted by two back-to-back arranged cup-like electrodes. The first, lower voltage electrode, generally called g3; may be at 8 kV and the second, higher voltage electrode, generally called g4, may be at 25 kV. The facing surfaces of the first and second electrodes are separated by a gap of the order of 1 mm.

[0004] Convergence drift in color cathode ray tubes having such electron guns is a well-known but not fully understood problem. This problem appears as a result of the variation in the neck potential, which variation is caused by the condition of the outside surface of the neck glass at switch-on of the high tension voltage. The initial neck potential is increased by the building-up of the neck charge due to the beam current. This building-up of the neck charge is visible as a growing misconvergence of the electron beams.

[0005] Various proposals for reducing convergence drift include increasing the size of the dam, that is, increasing in the east-west direction the extent of the electrode surface between its outer edge and the nearest aperture. In so doing the influence of the wall voltage on the lens fields is reduced. Another proposal is to reduce the size of the gap between the facing surfaces of the lens electrodes. While this will reduce the influence of the wall voltage on the lens fields it has the disadvantage that as a result of the close proximity of these electrodes stray, cold emissions are produced by the lower voltage focusing electrode. As the present day trend is to enlarge the gap to avoid the production of cold emissions, this option is not acceptable.

[0006] United States Patent US 4,868,454 proposes eliminating convergence drift by providing metallic conductive coatings on the internal wall of the neck. While such conductive coatings reduce convergence drift, they will not eliminate this problem. Additionally the production of these conductive coatings, usually as metallic mirrors, generally takes place naturally during spot-knocking when very high voltages, up to 80 kV, are applied to electrodes of the electron gun. However the extent and quality of these metallic mirrors are dependent on the activity which takes place during spot-knocking. As the level of this activity varies from tube to tube it is unpredictable and in consequence the quality and repeatability of these metallic mirrors is variable and unacceptable for volume production.
Providing metallic coatings before the spot-knocking operating stage is not a solution because during spot knocking the metallic coatings can be damaged. Also pitting of the neck glass may occur causing loose glass particles to be deposited on the lens electrodes, which particles may comprise cold emission sources. Pitting may also lead to undesired cracking of the neck glass. Thus providing metallic mirrors, although such provision has possible a beneficial effect on convergence drift is problematic.

SUMMARY OF THE INVENTION

[0007] An object of the present invention is to reduce significantly the convergence drift in in-line electron gun colour cathode ray tubes without having to resort to the use of metallic mirrors..

[0008] According to the present invention there is provided a colour cathode ray tube having an envelope comprising a neck, and an in-line electron gun for generating three electron beams extending in an in-line plane, said electron gun being positioned in the neck and comprising a main lens part comprising a low voltage focusing electrode and a high voltage focusing electrode, the facing surfaces of the low and high voltage electrode being separated from each other by a main lens gap, and means for reducing convergence drift, characterized in that the electron gun is at an end facing away from the neck provided with a sets of springs, comprising

- a first subset of springs extending away from the electron gun touching an inner conductive layer on a cone of the envelop and
- a second subset of springs extending in the opposite direction, wherein the springs of the second subset touch the neck internally at a position near the main lens gap without extending to or beyond the low voltage electrode, and substantially in a plane parallel to the in-line plane.

[0009] Investigative tests on colour cathode ray tubes having bipotential focusing lenses with the gap between the facing surfaces of the lens electrodes have shown that the second set of springs can be very effective in correcting potential variations causing convergence drift. The springs should not extend beyond the gap, i. e. to or beyond the low voltage electrode. The second subset of springs is in operation at the voltage of the high voltage electrode. Should the springs extend to or beyond the low voltage electrode, a potential difference

between the springs and the low voltage electrode could cause a flash-over between these elements and/or influence the lens field negatively. The springs touch the inside of the neck substantially in the in-line plane. Touching the glass in a plane perpendicular to this plane has little or no effect. The springs extend in the in-line plane, i.e. at East-West positions. It is probably the slow built-up of charges at these areas of the neck that is a major cause of the convergence drift. By having the springs touch the inside of the neck at these positions (as compared to placing the North-South) a efficient reduction in convergence drift is achieved.

[0010] Hereinbelow springs that extend backwards, i.e. from the end of the gun towards the cathode (back into the neck) are also called "retrograde springs", to distinguish them from the often used forward (towards the screen) pointing springs.

[0011] It is preferred that the springs of the second subset do not extend beyond a centre plane of the main lens gap, i.e. they stay at the "high voltage electrode-side" of the main lens.

[0012] It is remarked that springs extending in two opposite directions are known from US 4,665,340. However the retrograde springs do not extend to the gap. Also the gun is not an in-line gun

JP 57163945 also shows springs that extend in two direction. However, in this document the retrograde springs touch the inside of the neck at positions opposite a glass bead, which does not correspond to the positions in accordance with the invention. Furthermore the retrograde springs extend past the gap.

BRIEF DESCRIPTION OF THE DRAWING

[0013] The present invention will now be described, by way of example, with reference to the accompanying drawing figures, wherein:

FIG. 1 is a diagrammatic horizontal cross-sectional view through an embodiment of an in-line gun colour cathode ray tube made in accordance with the present invention,

FIG. 2 is a diagram explaining the convergence drift problem as presently understood,

FIG. 3 is a diagrammatic view looking in the north-south direction at an electron gun having a bipotential main focusing lens,

FIG. 4 is a view perpendicular to that shown in FIG. 3, and

FIG. 5 is a view on the line V--V' in FIG. 4.

FIG. 6 schematically explains a configuration of g3 and g4 electrodes.

FIG. 7 shows a part of an electron gun.

FIG. 8 shows an electron gun in a neck of a tube.

Fig. 9 illustrates the positive effect of the invention on convergence drift.

Fig. 10 illustrates various springs.

Fig. 11 illustrates the effect of the springs on the drift.

[0014] In the drawing figures, corresponding reference numerals have been used to indicate the same parts.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0015] The colour cathode ray tube shown in FIG. 1 comprises a glass envelope 10 which is composed of a display window 12, a cone 13 and a neck 14. An electron gun system 15 is provided in the neck 14, which system comprises three in-line arranged electron guns formed by separate cathodes and four unitary grid electrodes g1, g2, g3 and g4 juxtapositioned by glass beads 16, 17 (FIGS. 3 to 5). The electron gun system 15 generates three electron beams 19, 20 and 21, respectively, with their axes situated in one plane (the plane of the drawing) which plane for convenience of description may be termed the east-west plane. In the electron gun system 15 the axis of the central electron beam 20 coincides with the tube axis 22. The display window 12 comprises on its inside a plurality of triplets of phosphor lines. Each triplet comprises a line consisting of a blue-luminescing phosphor, a line consisting of a green-luminescing phosphor, and a line consisting of a red-luminescing phosphor. All the triplets together constitute the display screen 23. The phosphor lines are substantially perpendicular to the plane of the drawing. Positioned in front of the display screen 23 is a shadow mask 24 in which a plurality of elongate apertures are provided through which the electron beams 19,20 and 21 pass and impinge only upon phosphor lines of one colour. The three electron beams situated in one plane are deflected by a system of deflection coils 26.

[0016] A conductive film 28 is provided on the external surface of the cone 13. A conductive layer 42 is provided on the internal surface of the cone and extends into the neck to the vicinity of a centring cup 30, to which the layer is electrically connected by forward extending springs 40 (FIGS. 3 and 4) attached to the cup 30. These forward extending springs form the first subset of springs. It is remarked that in some publication this conductive layer is called a resistive layer, the use of the word "conductive" or "resistive" layer does not denote a fundamental difference. The inner layer's function is to provide electrode(s) of the electron gun, via the springs 40, a high voltage potential (typically 25-30 kVolt).

[0017] Referring to FIG. 2, the drawing shows a part of an in-line electron gun system, more particularly the bi-potential lens formed by the electrodes g3, g4 and the centring cup 30 connected by spring contacts 40 to the conductive layer 42 on the inside of the cone 13 and extending part way into the neck 14. No means have been shown to prevent convergence drift or stabilize convergence. In operation the grid g3 is typically at 8 kV and the grid g4 is typically at 25 kV. At switch-on, a potential builds-up rapidly on the internal surface of the neck 14 due to a capacitive coupling between the electrode g3,g4 and the internal surface. As the glass of the envelope is a dielectric and the external surface of the neck is capacitively coupled to ground or to another convenient voltage reference point, then a potential builds-up very rapidly on the external surface of the neck 14 at switch-on.

[0018] However an unstable condition prevails, especially immediately following switch-on, because as a result of beam current there is an additional slow potential build-up on the internal surface which causes the convergence of the outer electron beams 19 and 21 to drift from say the broken line condition to the acceptable full-line condition. Assuming the condition of the external surface of the neck to be dry then in the stable condition a voltage of about 18 kV has built-up on the internal surface of the neck 14. This voltage affects the focusing lens field particularly that associated with the nearest electron beam 19 (or 21) because the electron gun system 15 is asymmetrical. However because it is stable the convergence remains unchanged.

[0019] The invention relates to a novel manner of reducing convergence drift. Figures 3 to 5 illustrate the invention. At an end, in this example at the cup 30, the electron gun is provided with two subsets of springs, forward extending springs 40 touching the conductive layer are provided. Within the neck, backward extending springs 41 are provided touching the internal surface of the neck 14 near the gap between the grid g3 and the grid g4 on and about the east-west plane containing the electron beams 19,20,21.

Investigative tests on colour cathode ray tubes having bipotential focusing lenses with a gap 38 between the facing surfaces of the lens electrodes g3, g4 have shown that the second set of springs 41 can be very effective in correcting potential variations causing convergence drift. The springs 41 should not extend beyond the gap 38, i.e. to or beyond the low voltage electrode g3. The second subset of springs 41 is in operation at the voltage of the high voltage electrode. Should the springs 41 extend to or beyond the low voltage electrode g3, a potential difference between the springs and the low voltage electrode could cause a flash-over between these elements 41 and g3 and/or influence the lens field in the main lens formed between g3 and g4 negatively. The springs 31 touch the inside of the neck substantially in the in-line plane (i.e. East-West). Touching the glass in a plane perpendicular to this plane has little or no effect. The springs extend in the in-line plane, i.e. at East-West positions. It is probably the slow built-up of charges at these areas of the neck that is a major cause of the convergence drift. By having the springs touch the inside of the neck at these positions (as compared to placing the North-South) a efficient reduction in convergence drift is achieved.

[0020] In fig. 5 the centring cup 30 is partly shown.

[0021] Fig. 6 shows an arrangement of an g3 and g4 electrode. In this example both of the g3 and g4 electrode comprise a base plate g3base, g4 base inside the electrode and a rim part g3rim, g4rim. In this fig. 6 also the centre plane 38a (i.e. the plane at equal distance of the electrodes g3, g4) is shown.

[0022] Fig. 7 shows a detail of an electron gun. The position of the second sub-set of springs 14 vis-a-vis the rest of the gun is clearly shown. In this example the springs 40 and 41 are separate elements, in embodiments the springs 40 and 41 which in this figure touch each other may form one element. This would reduce the number of elements.

[0023] Fig. 8 shows an electron gun inserted in a neck 14.

[0024] Fig. 9 shows the positive effect of the invention.

[0025] Electron guns have been fitted with springs 41 and sealed in 32WSRF tubes. Figure 9 shows the 4px convergence drift of two guns with springs 41 (line 92) compared to two guns with no such springs 41, all the other parameters having been kept the same. It is evident that the pair of springs 41 allows a very large drift reduction (nearly 4 times less). Moreover the roughly identical drift curves of the 2 guns with springs indicate 41 that the spread is low.

[0026] Fig. 10 illustrates various springs. These springs differ in the position where they touch the neck internally. The gap in these examples is 1.4 mm wide. In position A the springs touches the neck at a distance of 1.4 mm measured from a centre plane in the gap. In position B the spring touches the neck internally at a distance of 0.7 mm form the centre plane, i.e. just at the edge of the gap. In position C the spring touches the neck right at the position of the centre plane.

[0027] Fig. 11 illustrates the drift for the springs shown in fig. 10. In this example the drift without springs is approximately 0.6 mm. This differs from the drift in fig. 9, since each model has its' own drift behavior. However, comparing the drift with springs to the drift without springs, it is clear that using the springs as shown in fig 10., part A only a marginal effect is obtainable, Thus such springs fall outside the scope of the invention. The spring of example B, extending to the edge of the gap, give a substantially larger positive effect, and fall within the scope of the invention. The springs as in example C give an even greater effect, reducing the drift by some 70%, a very substantial positive effect. In preferred embodiment the springs therefore touch the neck at a position at a distance less than ¼ of the gap form a centre plane in the gap, where the centre plane is a plane at

equal distance from the electrodes at either side of the gap.

[0028] It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. The invention resides in each and every novel characteristic feature and each and every combination of characteristic features, even if not explicitly recited in the claims. Reference numerals in the claims do not limit their protective scope. Use of the verb "to comprise" and its conjugations does not exclude the presence of elements other than those stated in the claims. Use of the article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements.

Claims

1. A colour cathode ray tube having an envelope (10) comprising a neck (14), and an in-line electron gun (15) for generating three electron beams (19, 20, 21) extending in an in-line plane, said electron gun (15) being positioned in the neck (14) and comprising a main lens part comprising a low voltage focusing electrode (g3) and a high voltage focusing electrode (g4), the facing surfaces of the low and high voltage electrode being separated from each other by a main lens gap (38), and means for reducing convergence drift, **characterized in that** the electron gun is at an end (30) facing away from the neck (14) provided with a sets of springs, comprising

   - a first subset of springs (40) extending away from the electron gun touching an inner conductive layer (42) on a cone (13) of the envelop (10) and
   - a second subset of springs (41) extending in the opposite direction, wherein the springs of the second subset touch the neck internally at a position near the main lens gap (38) without extending to or beyond the low voltage electrode (g3), and substantially in a plane parallel to the in-line plane (East-West).

2. A colour cathode ray tube as claimed in claim 1, **characterised in that** the springs therefore touch the neck at a position at a distance less than ¼ of the gap form a centre plane in the gap, where the centre plane is a plane at equal distance from the electrodes at either side of the gap.

3. A colour cathode ray tube as claimed in claim 1, **characterised in that** the springs of the second subset do not extend beyond a centre plane (38a) of the main lens gap.

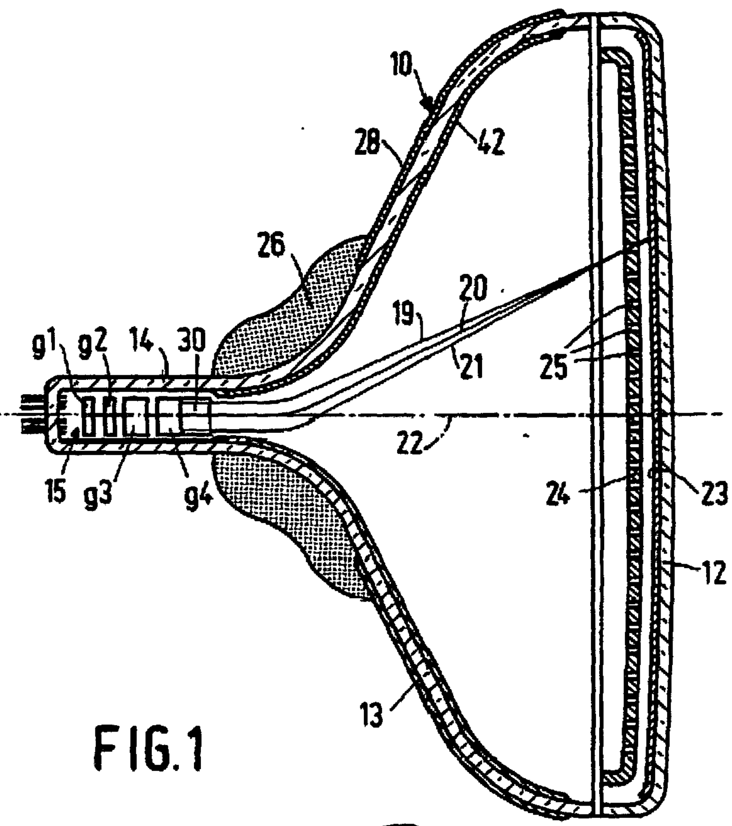
10
28
42
26
20
19
25
21
g1
g2
14
30
22
15
g3
g4
24
23
12
13

FIG.1

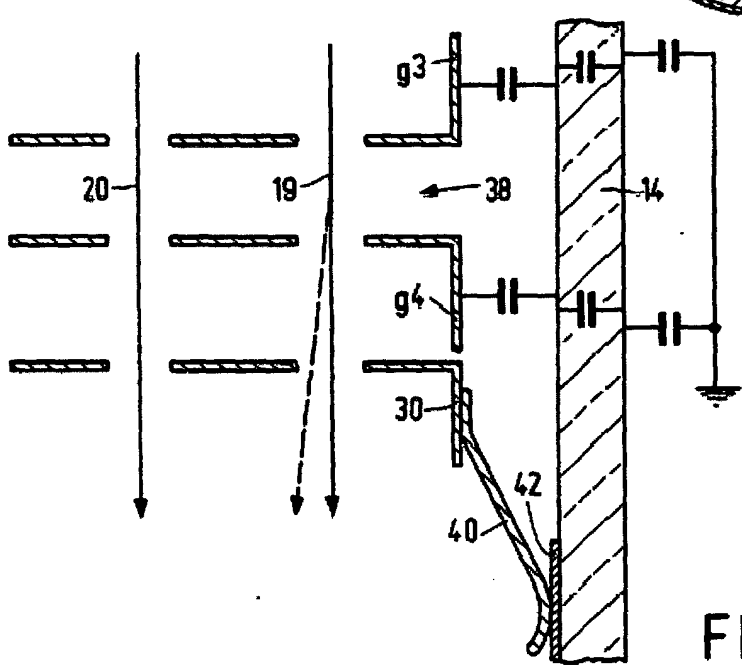
g3
20
19
38
14
g4
30
42
40

FIG.2

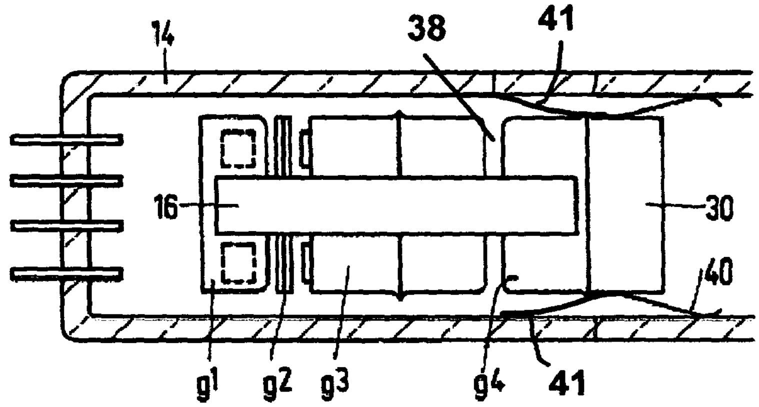

FIG.3

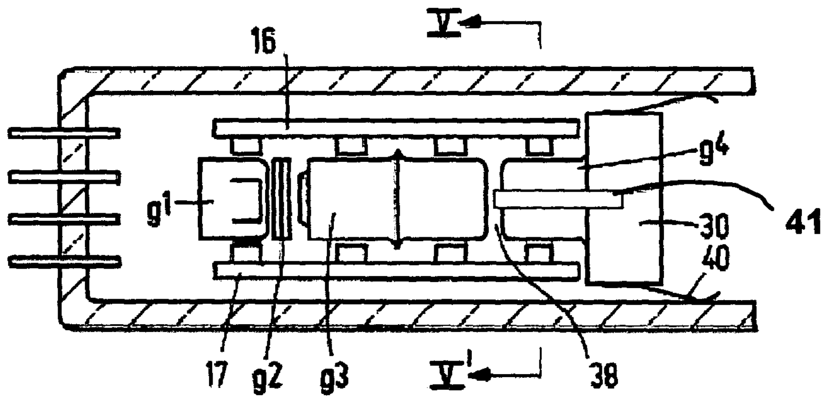

FIG.4

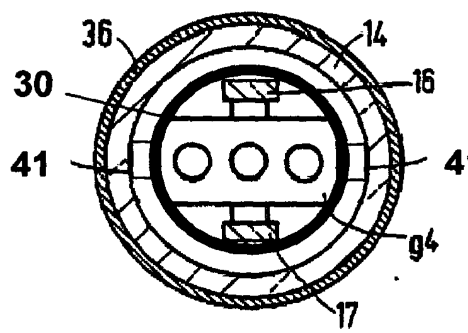

FIG.5

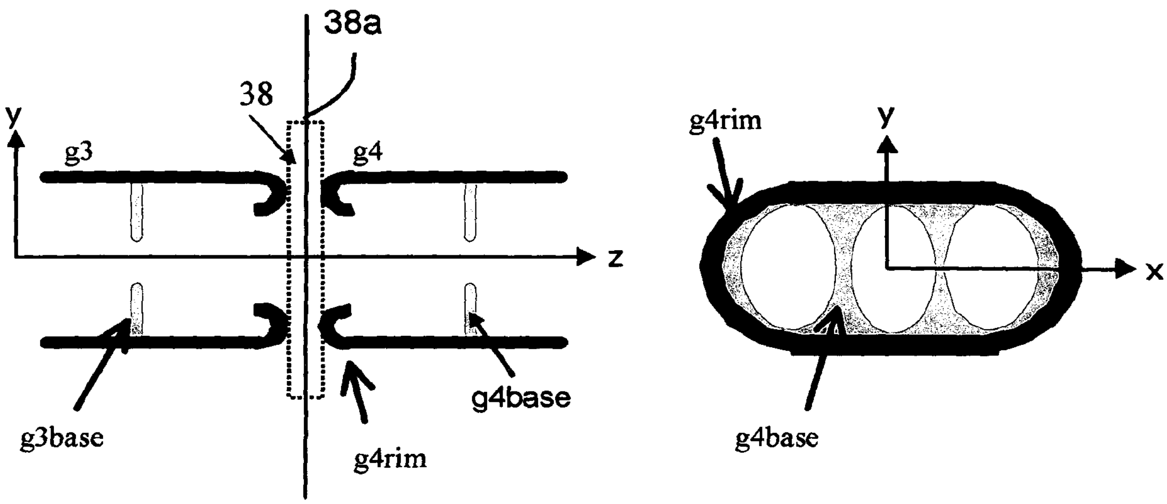

Fig. 6

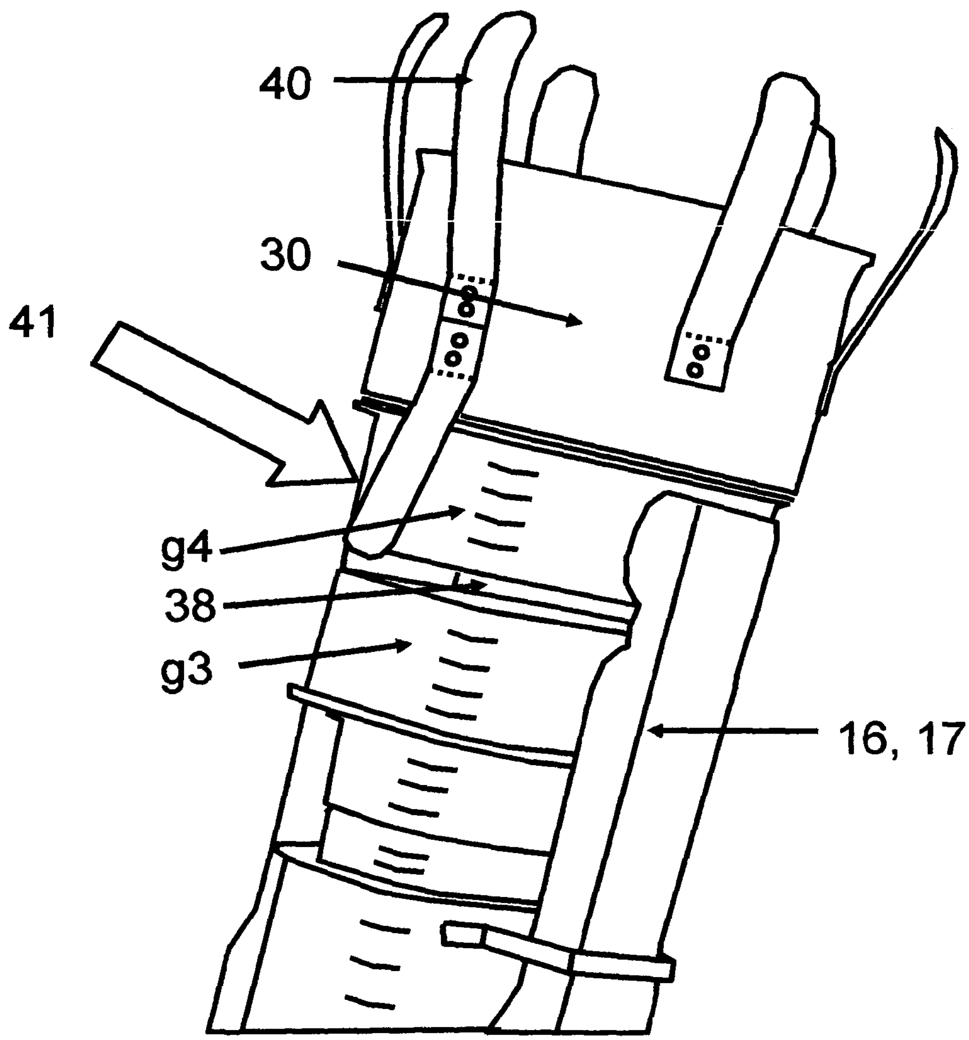

Fig. 7

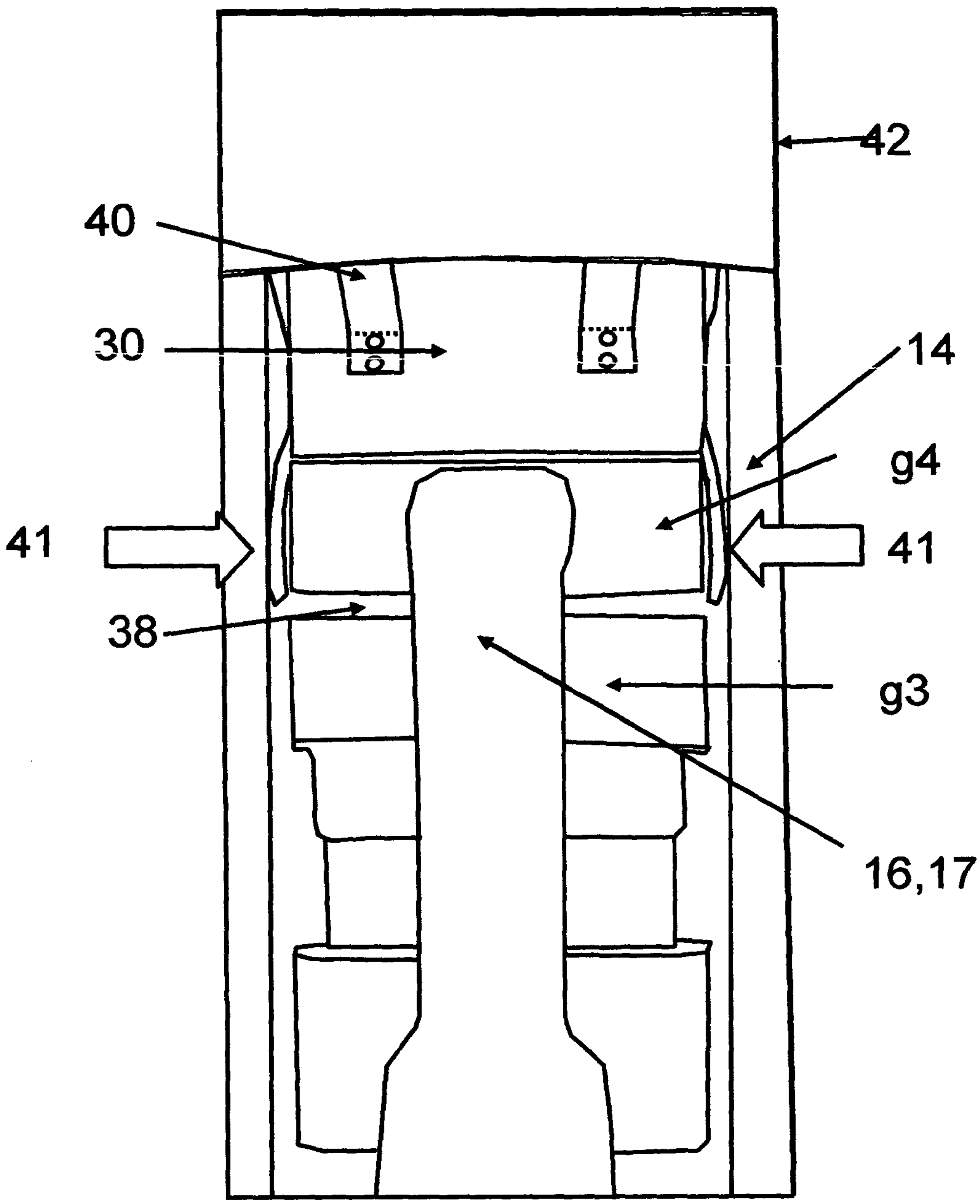

Fig. 8

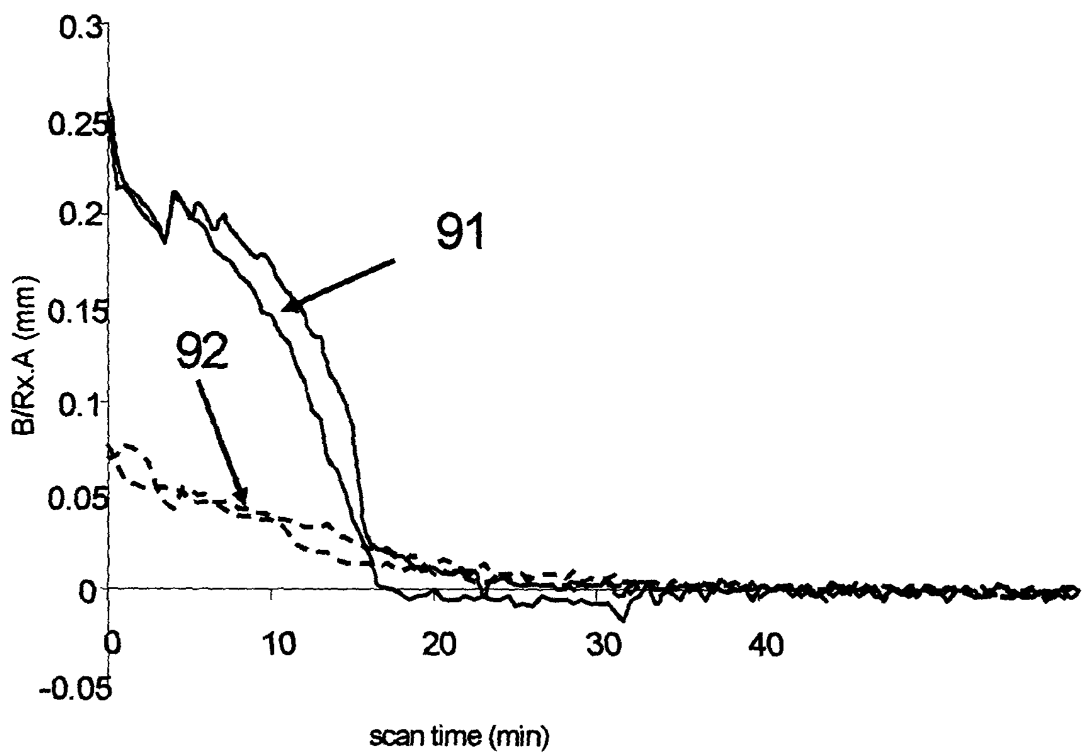

Fig. 9

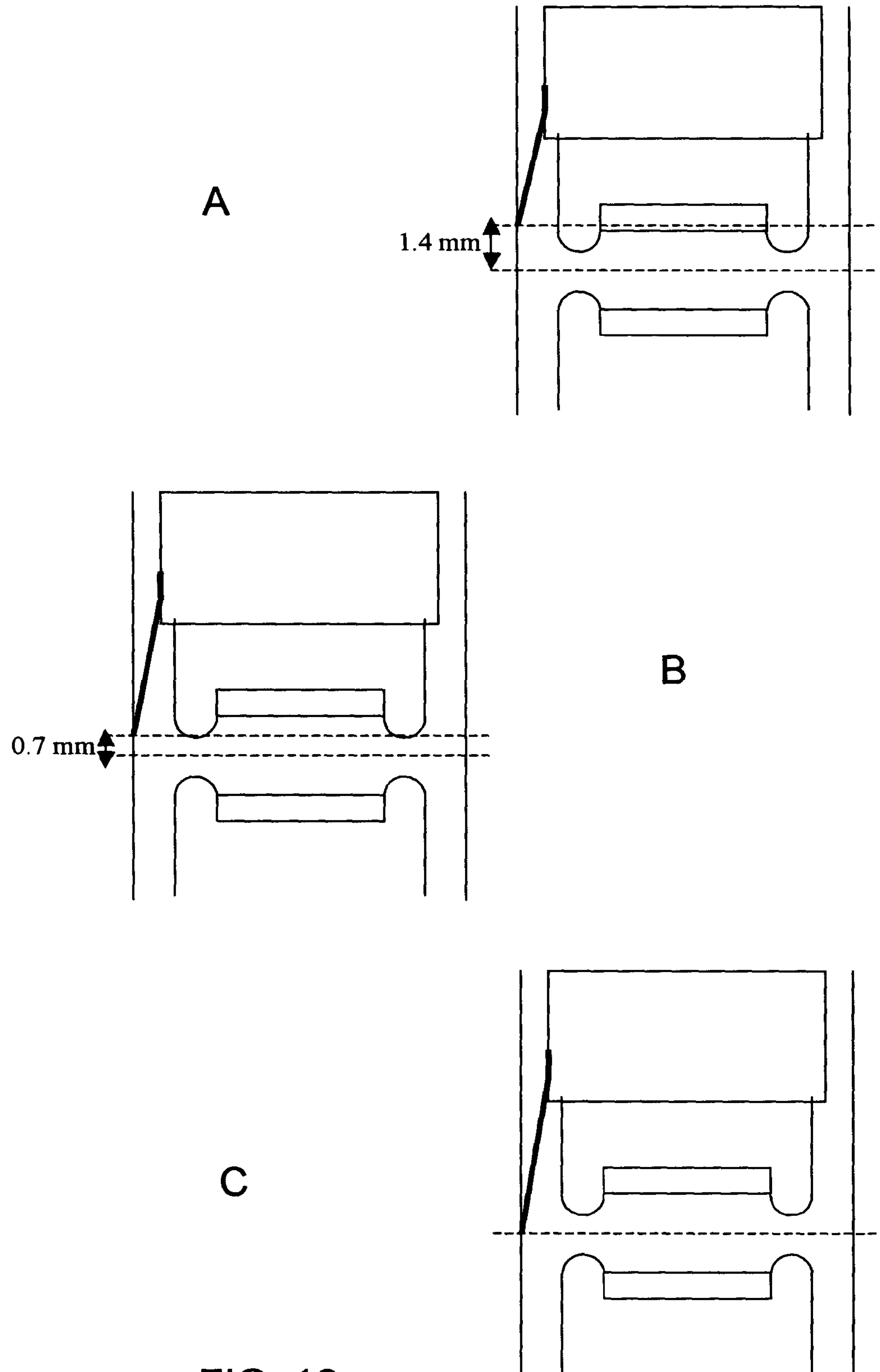

FIG. 10

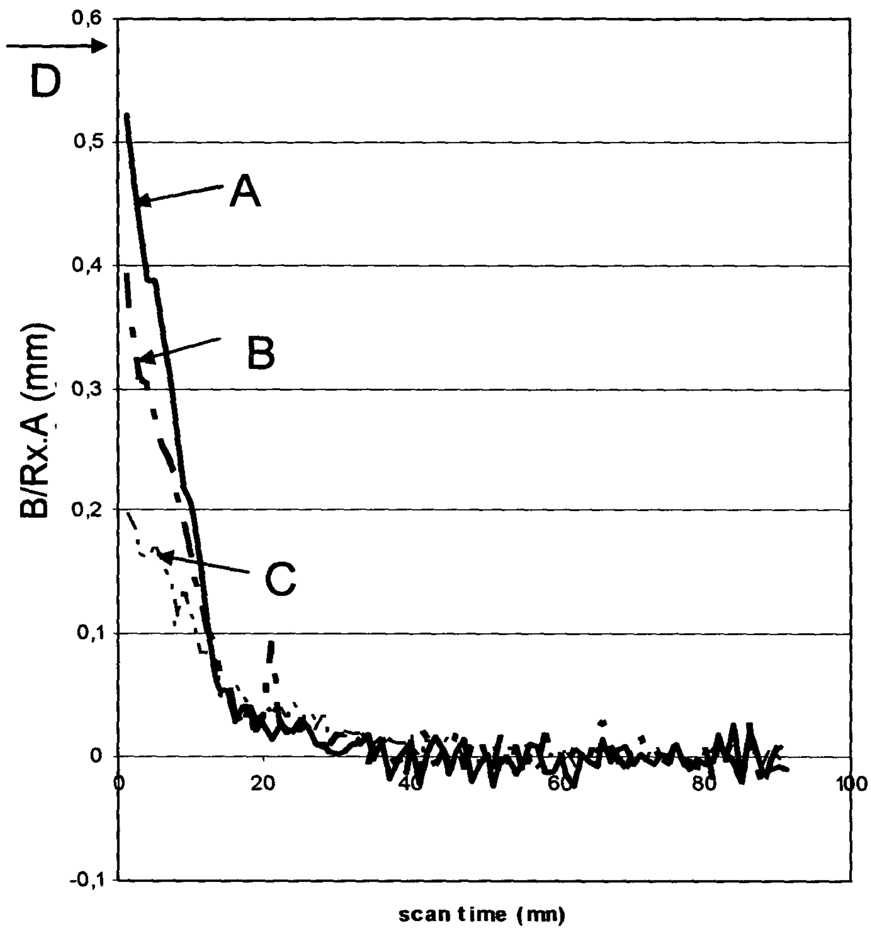

FIG. 11

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EUROPEAN SEARCH REPORT

Application Number
EP 03 07 8698

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 4 100 453 A (VAN DEN EINDEN HENRICUS FRANSI ET AL) 11 July 1978 (1978-07-11) * figure 2 * * column 2, lines 45-59 * * column 3, lines 15-36 * -----	1	H01J29/48 H01J29/50
A	PATENT ABSTRACTS OF JAPAN vol. 0091, no. 73 (E-329), 18 July 1985 (1985-07-18) & JP 60 047348 A (TOSHIBA KK), 14 March 1985 (1985-03-14) * abstract; figures 2a,2b * -----	1	
A,D	EP 0 281 197 A (PHILIPS NV) 7 September 1988 (1988-09-07) * figures 3-5 * -----	1	
A	US 4 337 409 A (VAN DER HEIJDEN ANTONIUS W F ET AL) 29 June 1982 (1982-06-29) * column 3, line 46 - column 4, line 5; figure 2 * * column 5, lines 29-49; figure 4 * -----	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7) H01J
A	US 2 852 716 A (MARTIN LAFFERTY JAMES) 16 September 1958 (1958-09-16) * column 4, lines 34-69; figure 2 * -----	1	

1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 March 2004	Reder, M

CATEGORY OF CITED DOCUMENTS

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26-03-2004

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 4100453	A	11-07-1978	NL	7610609	A	29-03-1978
			BE	847659	A1	26-04-1977
			CA	1065947	A1	06-11-1979
			DE	2648879	A1	30-03-1978
			FR	2365877	A1	21-04-1978
			GB	1561899	A	05-03-1980
			IT	1075985	B	22-04-1985
			JP	1307316	C	13-03-1986
			JP	53040268	A	12-04-1978
			JP	60019104	B	14-05-1985
JP 60047348	A	14-03-1985	JP	1776595	C	28-07-1993
			JP	4065488	B	20-10-1992
EP 0281197	A	07-09-1988	CN	88101173	A ,B	14-09-1988
			DE	3866895	D1	30-01-1992
			EP	0281197	A1	07-09-1988
			JP	63231847	A	27-09-1988
			KR	9608926	B1	09-07-1996
			US	4868454	A	19-09-1989
US 4337409	A	29-06-1982	NL	7904114	A	27-11-1980
			CA	1161092	A1	24-01-1984
			DE	3060335	D1	09-06-1982
			EP	0019975	A1	10-12-1980
			ES	8102413	A1	01-04-1981
			JP	1451924	C	25-07-1988
			JP	55161337	A	15-12-1980
			JP	62058104	B	04-12-1987
US 2852716	A	16-09-1958	GB	803221	A	22-10-1958

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